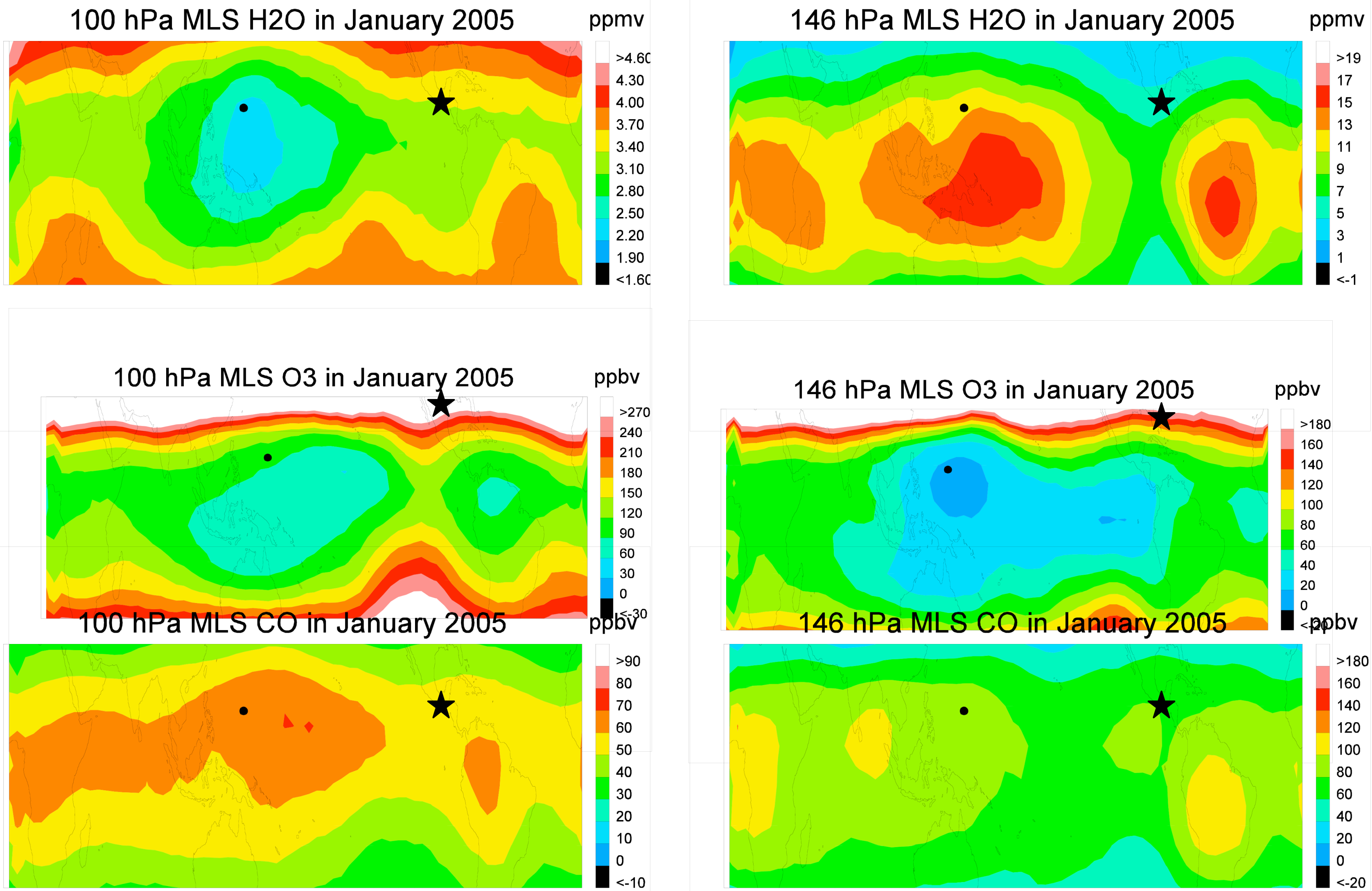
CR-AVE Flight Series

CR-AVE (Jan./Feb. 2006)
Measurement & Flight Priorities

Recommendations from the
Aura MLS Science Team

Nov. 30, 2005

MLS UT/LS measurements



The CR-AVE measurements in Jan. 06 will survey a somewhat different environment than the Guam Jan. 07 measurements are expected to sample.
Investigating and validating the absolute values of profiles as well as the space/time dependence over the 2006-2007 time period + local variations will be of interest.

MLS UT/LS measurements

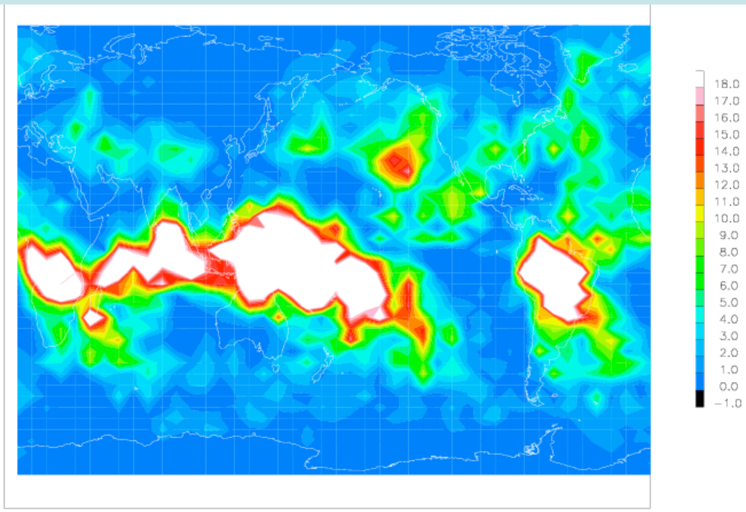
MLS also measures ice water content (IWC) and ice water path (IWP) for 'thick clouds'.

While flights from Costa Rica won't typically sample the maximum range of IWC expected for the tropics, we would like to do some statistical comparisons of IWC and slant IWP from MLS versus the aircraft remote data from the microwave radiometer (COSSIR) and the radar (CRS). *In situ* information on particle size distribution (30 to 500 μm) and shape is also desired (→ interpretation & constraints for IWC & IWP data).

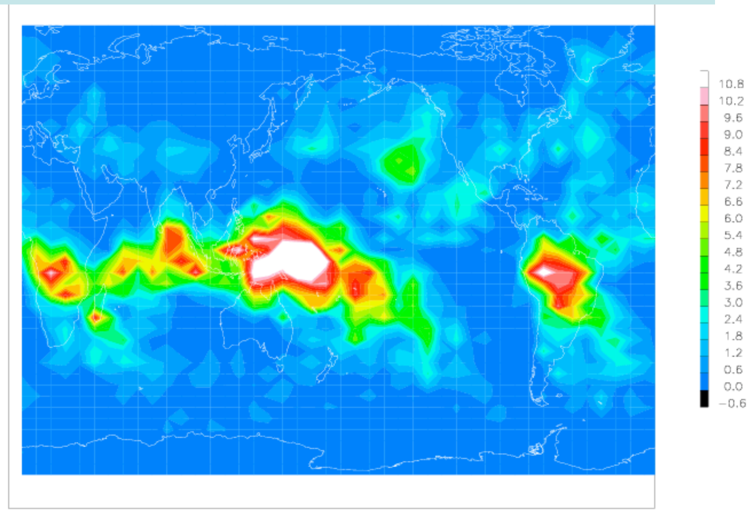
► MLS ice cloud info comes from 240 GHz as well as 640 GHz (better sensitivity to smaller ice particles)

- MLS IWC (240 GHz standard V1.51 product) is recommended for P < 215 hPa
- MLS 240 GHz IWP (planned new V2 product) is a measure of the cloud ice column above ~ 6 km
- MLS 640 GHz IWP (planned new V2 product) is a measure of the cloud ice column above ~ 10 km
  [not above 6 km because of stronger attenuation - impact of water vapor continuum and clouds]

240 GHz $IWP_{z > 6\ km}$ for Jan. 05



640 GHz $IWP_{z > 10\ km}$ for Jan. 05



MLS IWP (240 GHz) precision for monthly mean is 3.5 g/m^2, and 28 g/m^2 for single tangent point view.

MLS IWP (640 GHz) precision for monthly mean is 1.8 g/m^2, and 15 g/m^2 for single tangent point view.

Priorities for MLS (aircraft measurements and flight tracks) during CR-AVE

Profile information along the MLS sub-orbital track is desired (as in previous AVE campaigns)

H_2O, Relative Humidity, Temperature (500 - 50 hPa)

- H_2O: Priority 1: aircraft profiles along with frostpoint sondes versus the satellite data
- need to go from ~ 50 hPa to 500 hPa (and even lower for TES…)

Priority 2: address horizontal variability of differences between MLS & sondes or AIRS
- try some stacked level flights, mainly for ~ 200 to 400 hPa (with ~1.5 km separation)

- Temperature: Mainly for inferring relative humidity; also to check horizontal variability.

Cloud Information (coincident along - track 'curtain' sampling)

(a) remote sampling of thick clouds via COSSIR and CRS, along MLS track.
Compare to MLS IWC & slant IWP data (240 GHz [V-pol], 640 GHz [V-pol], 190 GHz [H-pol])
(b) *in situ* sampling of thick clouds from ~ 5 km to cloud top.
Get information along MLS track for particle size distribution (30 to 500 μm) & shape:

CO and O_3 (500 - 50 hPa)

May get 'some' pollution or BB-related variations near Costa Rica in January.
- Validation of some stronger variations (CO especially) would be of interest, if can fly close to land or pollution outflow, but measuring 'background values' will probably be more typical.
- Also, get aircraft ozone columns (from CAFS – level/stacked flights) for comparison to MLS

Lower priority

Profiles of UT/LS HCl, HNO_3, N_2O

OMI Validation Opportunities during CR-AVE Jan '06

17 January – 09 February 2006
San Jose, Costa Rica

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[1]KNMI, [2]GSFC

Costa Rica Aura Validation Experiment Jan '06

06-24 June 2005, Ellington AFB Houston, Texas

Remote Sensing Opportunities

- Flight paths (WB-57)

  straight and level, long legs, tropopause (separate strat/trop), along and across Aura/OMI track
  sample clean air over open ocean (reference), sample polluted air near cities (science and validation)

- Tropospheric NO2 column observations (ACAM)

  spatial variability, sources of NO2, transport and transformation, plumes
  open land, open ocean, land sea transition (albedo), cloud free, clean reference

- Atmospheric pollution (many instruments)

  ozone, NO2, SO2, aerosols, HCHO (ACAM, FCAS, NMASS, CAFS, S-HIS, O3)
  power plants, San Jose city, urban areas, rural areas, open ocean, cloud free, clean reference

- Urban scale observations of OMI species (many instruments)

  OMI sub-pixel spatial variability, tracking pollution plumes

- Earlier AVE remote sensing opportunities

  ozone column above low and high clouds (ACAM, CAFS, SHIS, CPL, CRS, COSSIR)
  cloud height, cloud structure (CPL, CRS, COSSIR)
  use and analyze both CAFS instruments to estimate total ozone column

Costa Rica Aura Validation Experiment Jan '06

06-24 June 2005, Ellington AFB Houston, Texas

In Situ Sensing Opportunities

- Flight paths (WB-57)

  spirals under pristine and polluted conditions, all the way down into the Boundary Layer!
  clean air over open ocean (reference), polluted air near cities and outflow (science and validation)

- Tropospheric NO2 column observations

  spatial variability, sources of NO2, transport and transformation, plumes, outflow
  vertical profile from BL to tropopause and several locations, cloud free, clean reference

- Atmospheric pollution (many instruments)

  O3, NO2, SO2, aerosols, HCHO, spatial variability, sources, transport and transformation
  vertical profile from inside BL to tropopause and several locations, cloud free, clean reference

- Aerosols

  aerosols type, composition and size distributions
  vertical profile from BL to tropopause and several locations
  cloud particles, cloud physics (CPI, CSI)

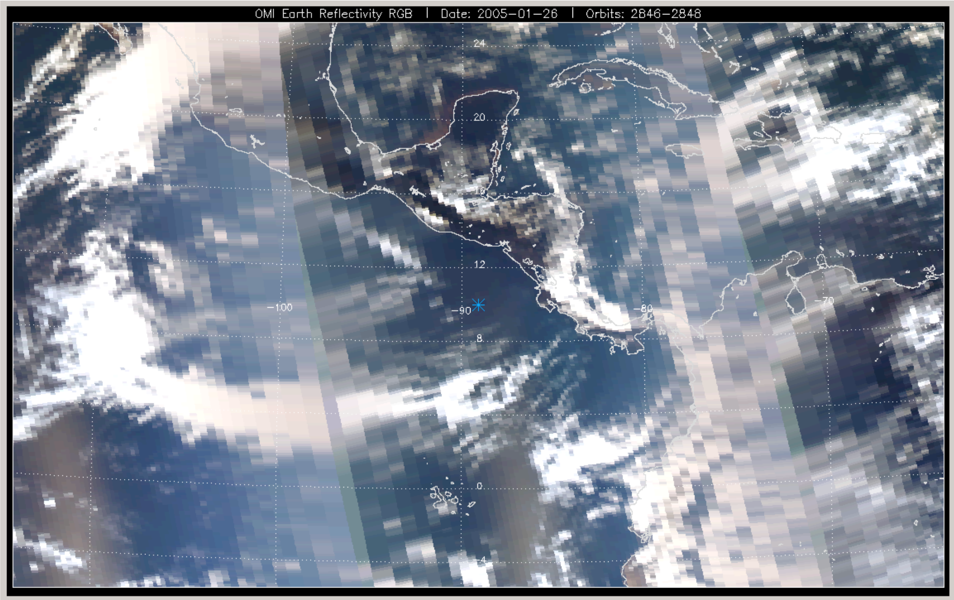
- Lessons learned from earlier AVE campaigns

  spirals take up much time hence separating in-situ from remote flights is a good idea
  vertical profiling should go down deep into the BL, half way is no way!

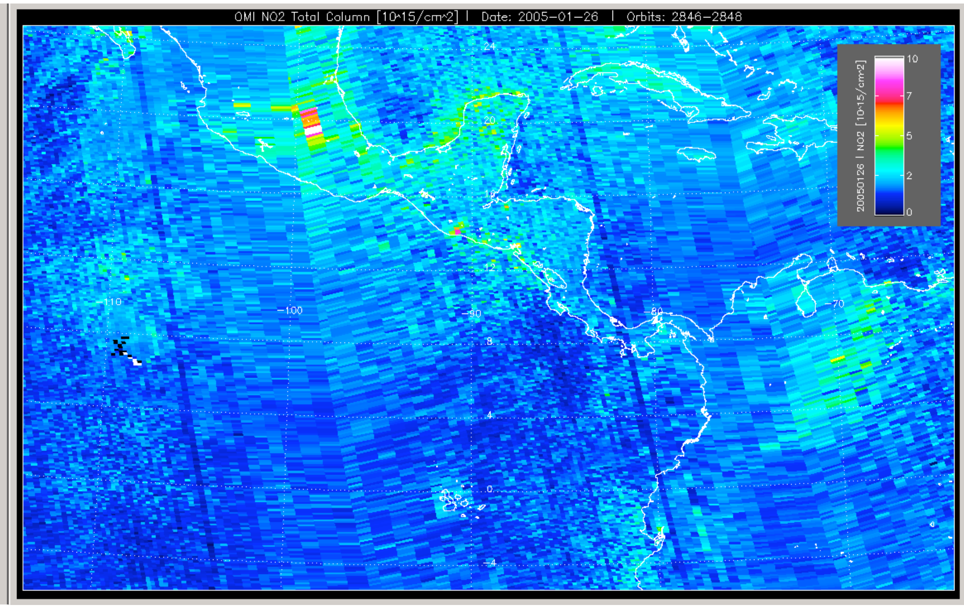
OMI

Last Year: Wednesday, 26 January 2005

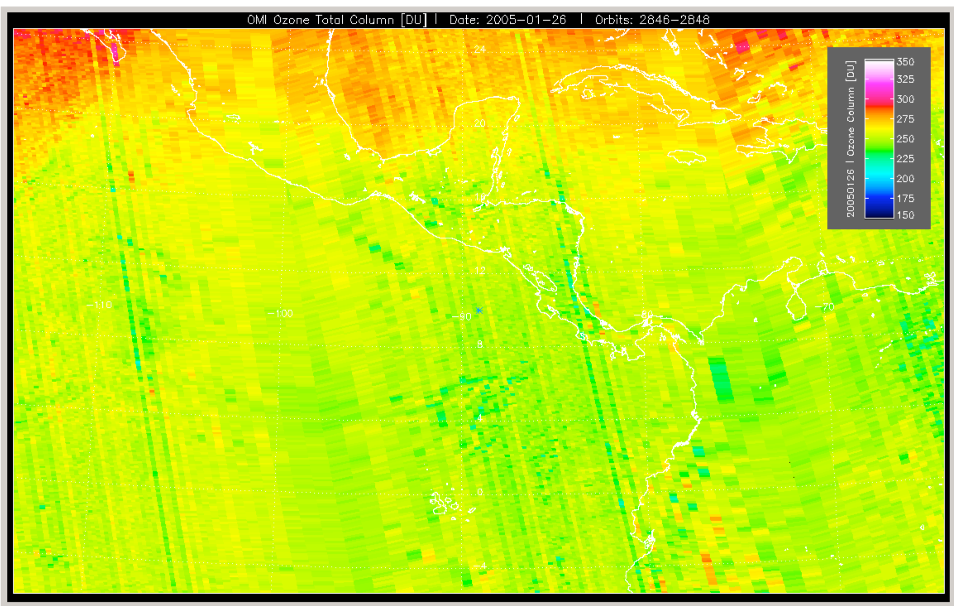
Level 1b RGB



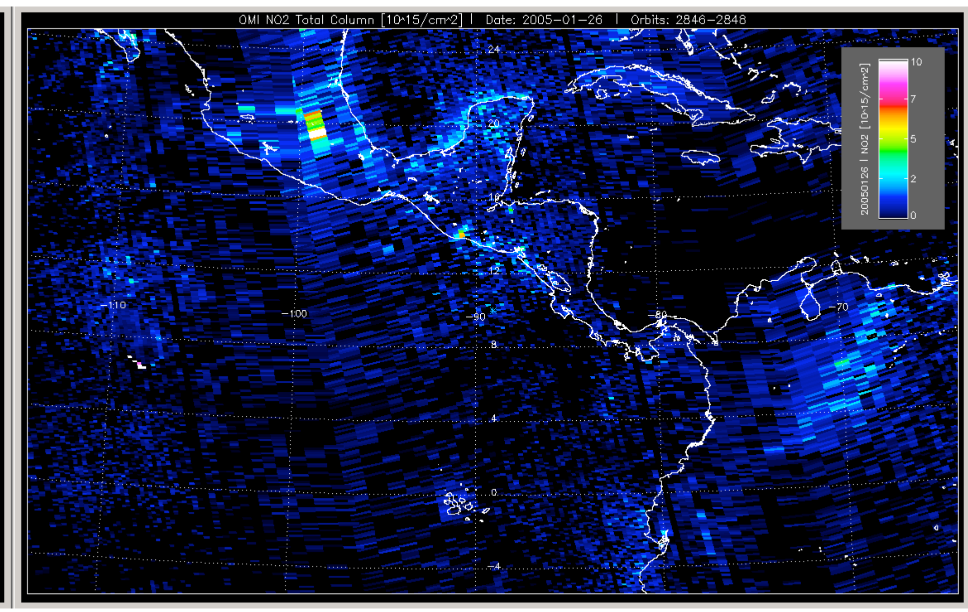
Total NO2 Column



Total Ozone Column

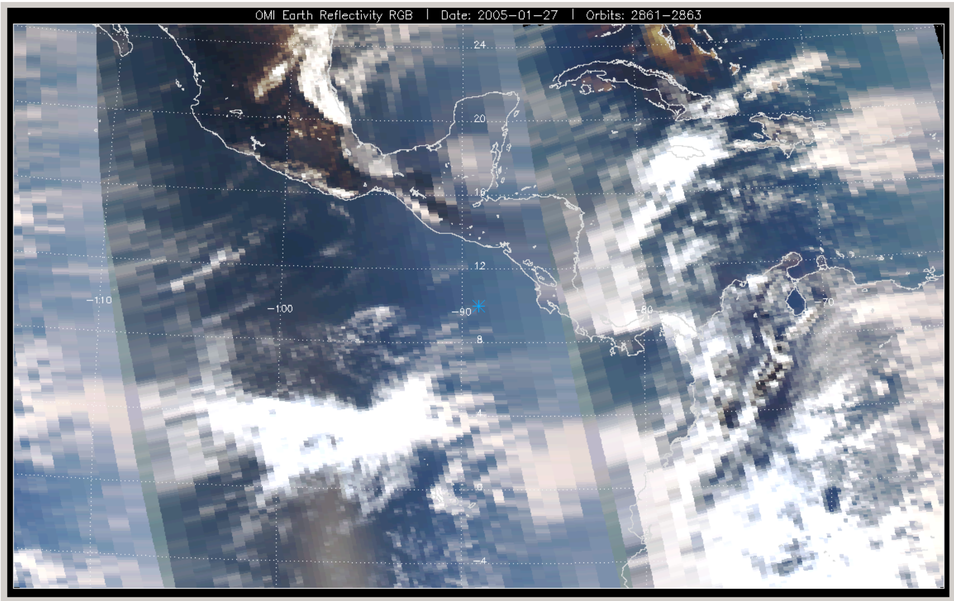


Tropospheric NO2 Column

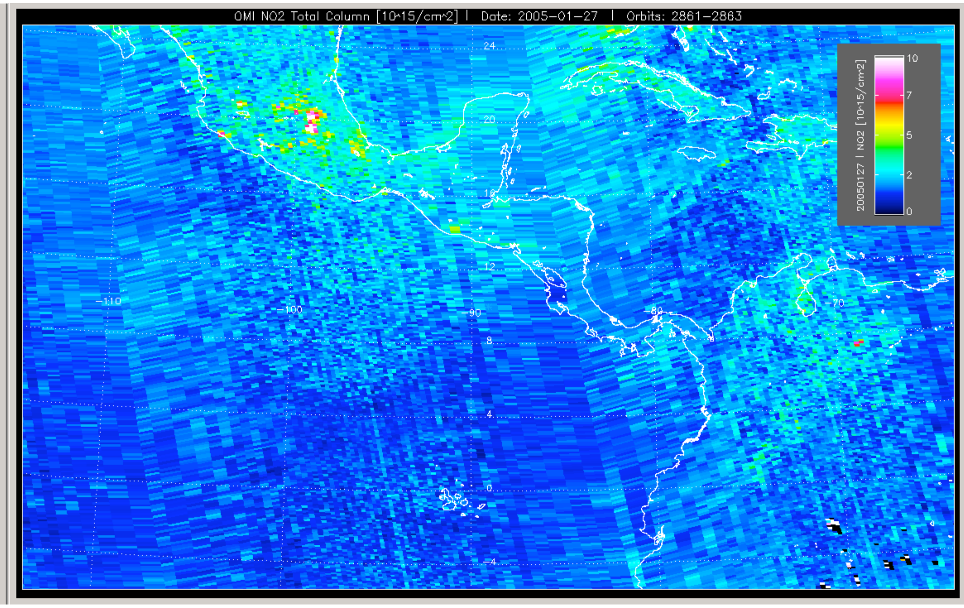


Last Year: Thursday, 27 January 2005

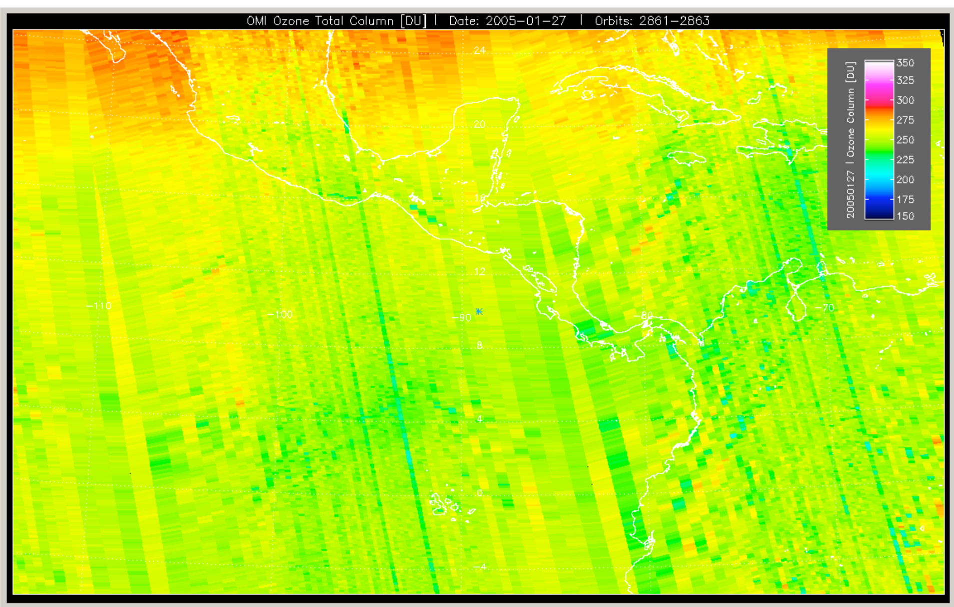
Level 1b RGB



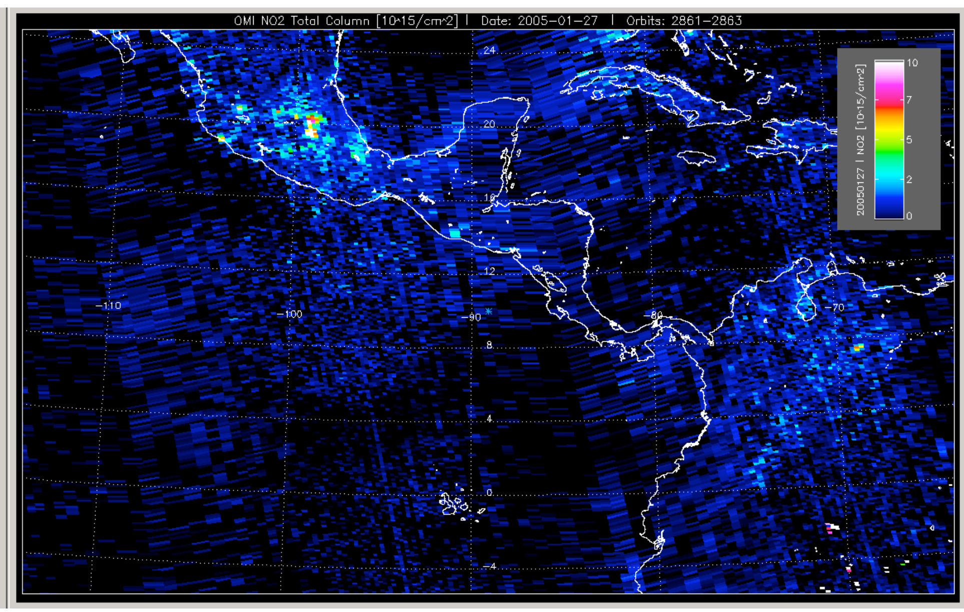
Total NO2 Column



Total Ozone Column

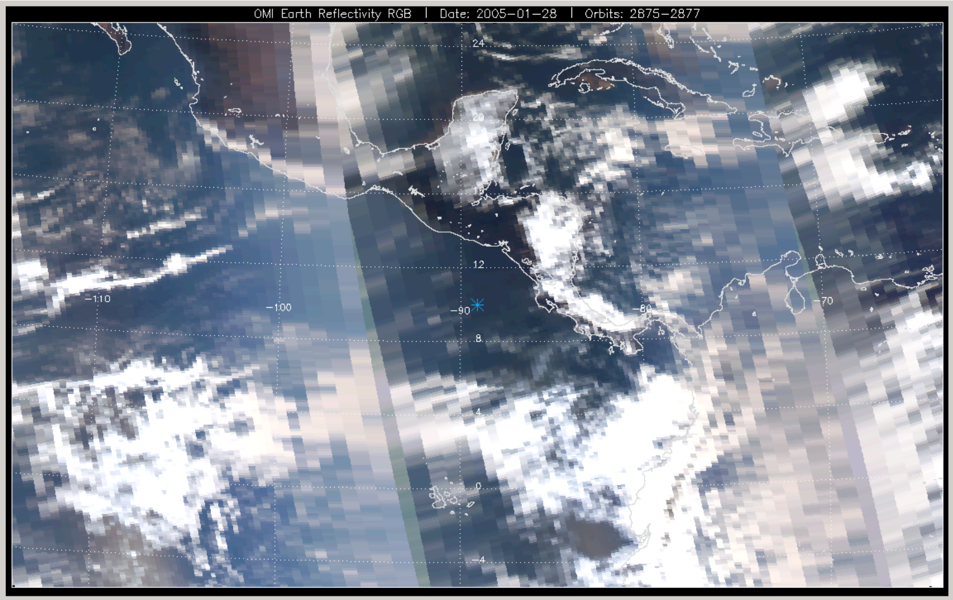


Tropospheric NO2 Column



Last Year: Friday, 28 January 2005

Level 1b RGB



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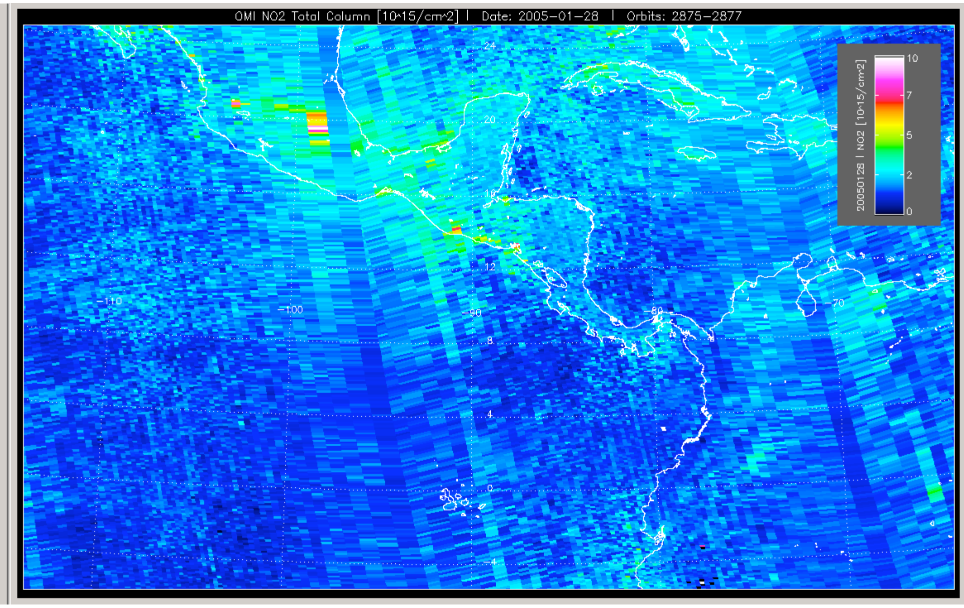
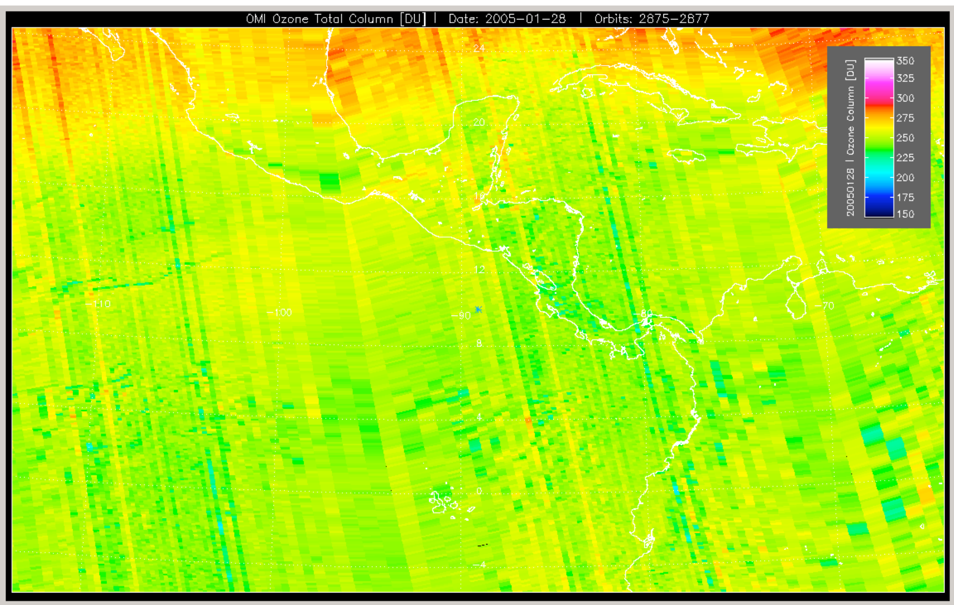
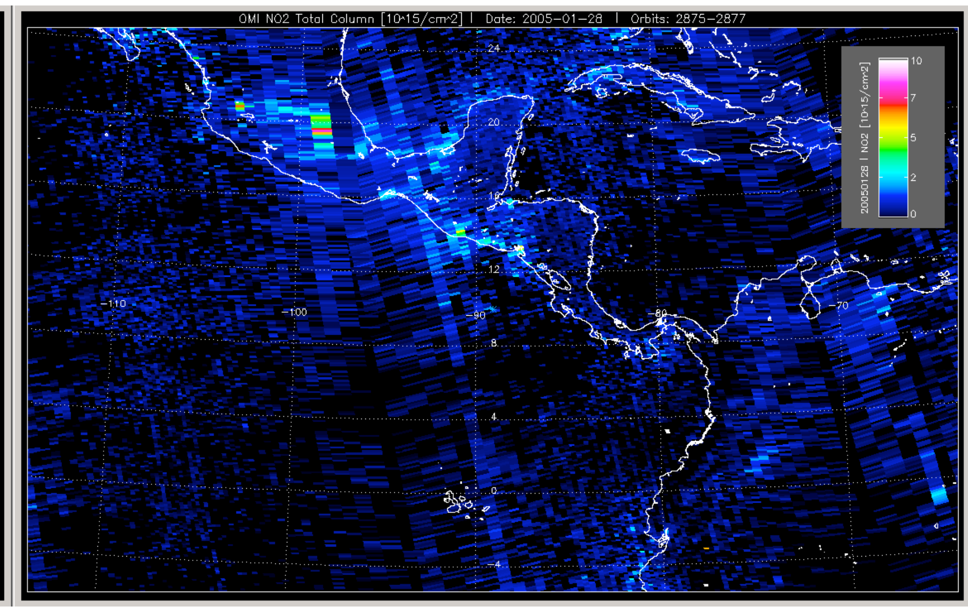


Total Ozone Column

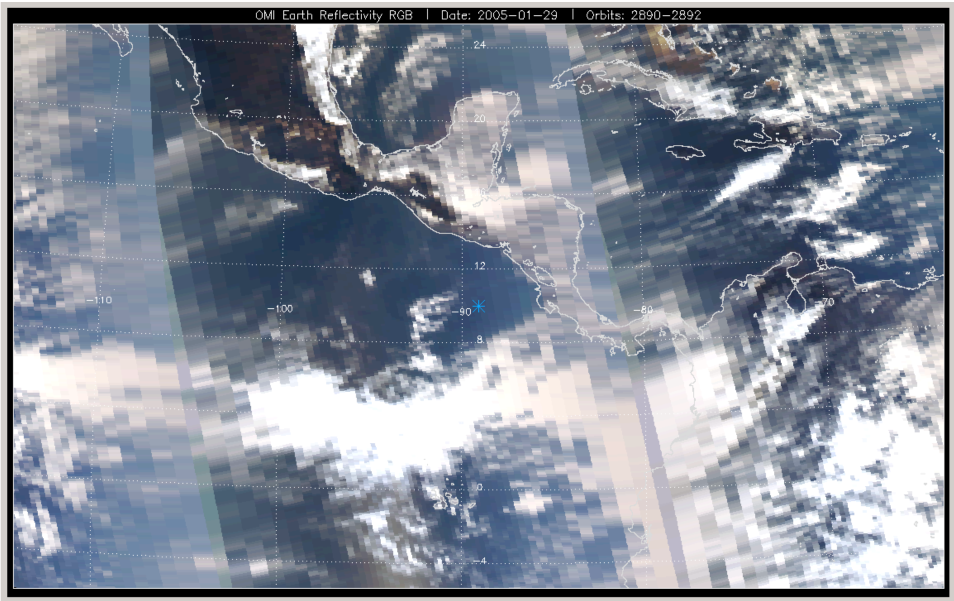


Tropospheric NO2 Column

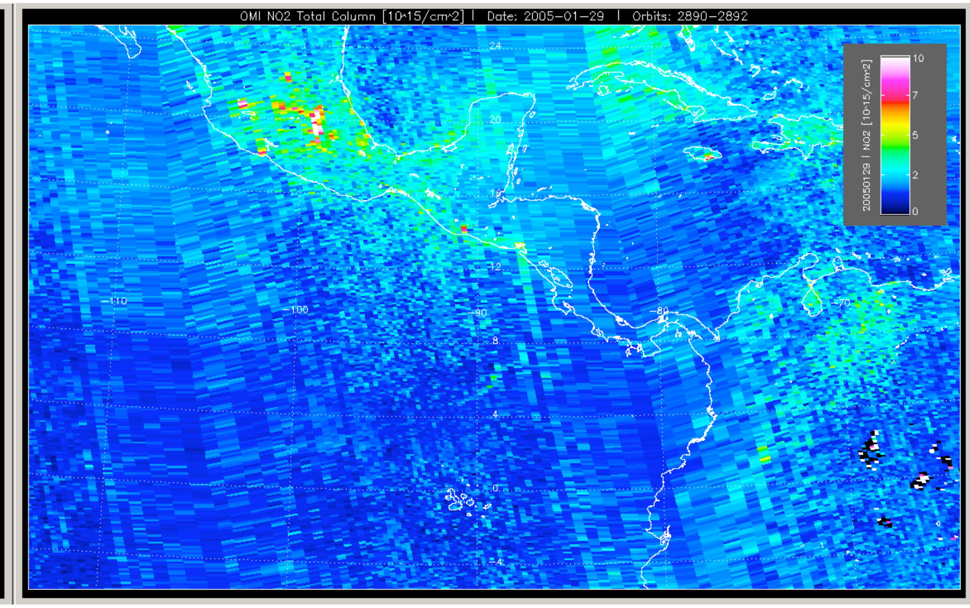


Last Year: Saturday, 29 January 2005

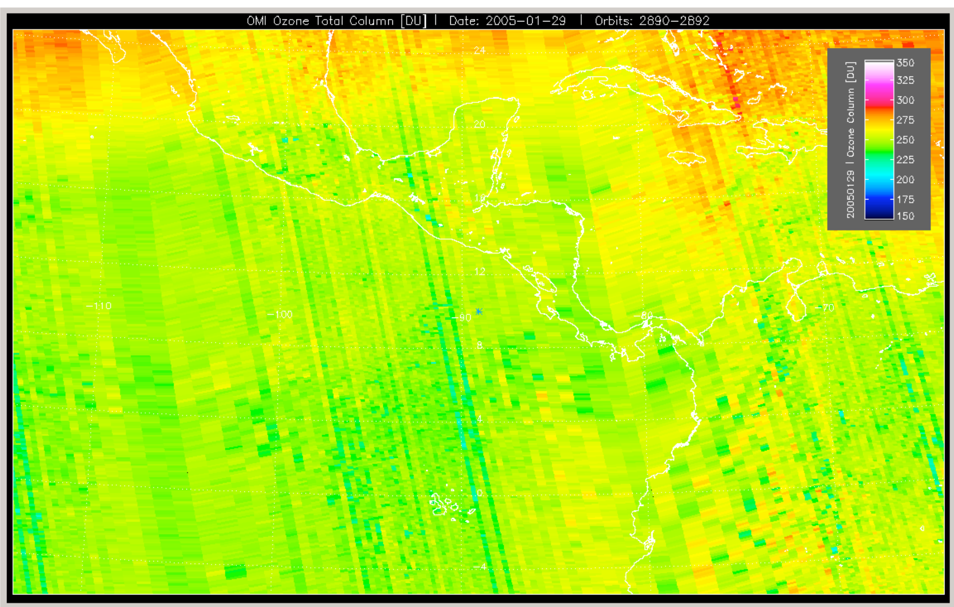
Level 1b RGB



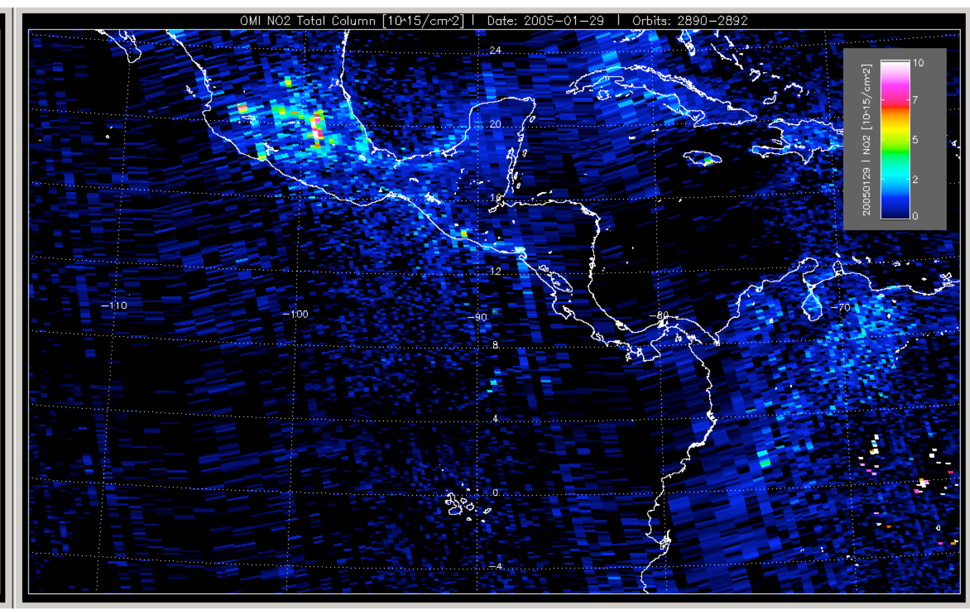
Total NO2 Column



Total Ozone Column

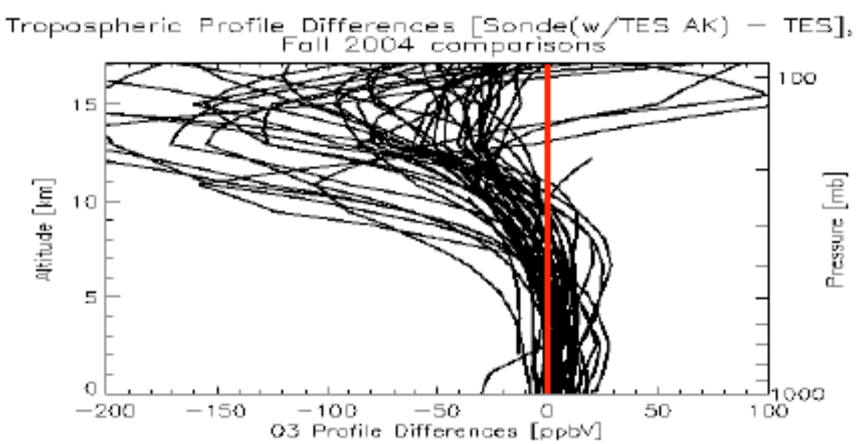


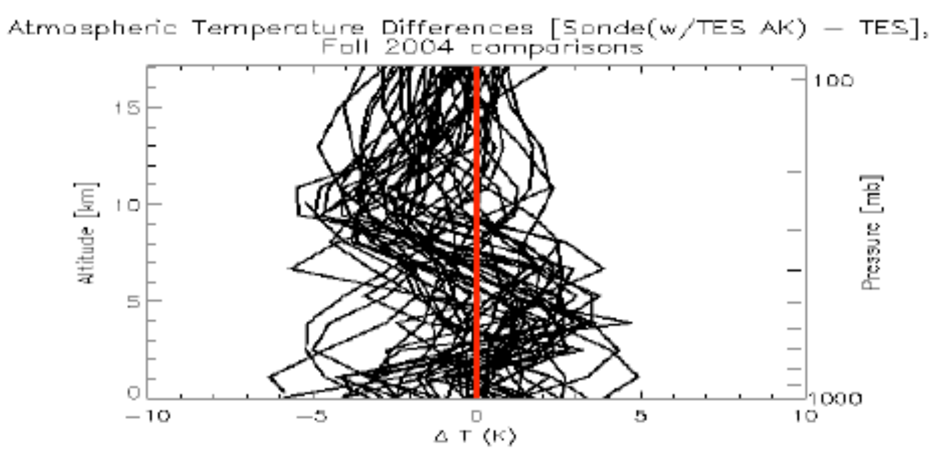
Tropospheric NO2 Column



TES requirements for Costa Rica AVE - 1

- TES objectives for remote sensing flights (first 2 weeks):
  - Highest priority: coincident measurements of SHIS with ozonesondes and radiosondes to carry out an upper tropospheric ozone experiment (resolve whether TES upper tropospheric bias in ozone is due to spectroscopy, calibration, or retrieval).
    - Coincidences with TES are not necessary for this experiment.
    - Opportunity for contrasting geophysical conditions to similar observations over ARM-CART SGP and Houston
  - Two flights with cloud-free coincidence between S-HIS and TES over the ocean.
  - Level flight along the TES nadir track is required for comparisons with the remote sensing instruments (especially S-HIS, CAFS, and CPL).





TES requirements for Costa Rica AVE - 2

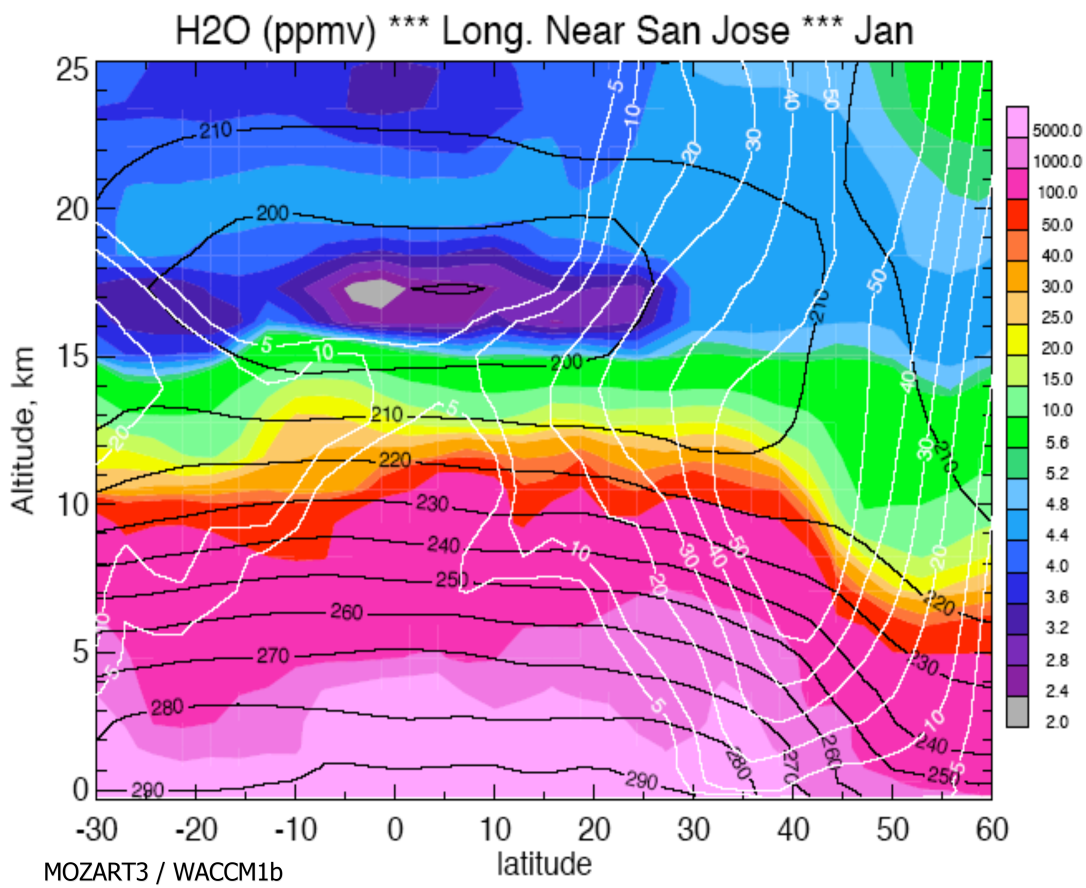
- Highest priority for in-situ: HNO_3 profiles spanning the entire altitude range of 8 to 20 km along the TES limb track (i.e. spiral, dive, or crenelation).
  - **Profiles from maximum altitude down to pressure levels deeper than 500 hPa are highly desirable - especially for carbon monoxide.**
  - During profiles, the aircraft should pass through air that is cloud-free (on a horizontal scale of 8 km x 5 km), but low clouds beneath the aircraft are acceptable.
  - A takeoff or landing on the afternoon of Jan. 31 is most useful for comparison with nearby TES nadir observations (I.e. CO and ozone profiles from the ground up).
- Feedback / lessons learned from previous AVE missions:
  - Flights on TES special obs days are preferable to flights on TES global survey days.
  - Have more profiles along TES tracks (both nadir and limb), and down to pressure levels deeper than 500 hPa.
- Additional measurement: HDO. This is highly desirable because aircraft measurements are the best way to validate this important TES science product.

HIRDLS Validation Priorities from Costa Rica AVE

B. Nardi, J. Gille, D. Kinnison, J. Craft,
S. Massie, H. Lee, M. Coffey, R. Khosravi

30 November 2005

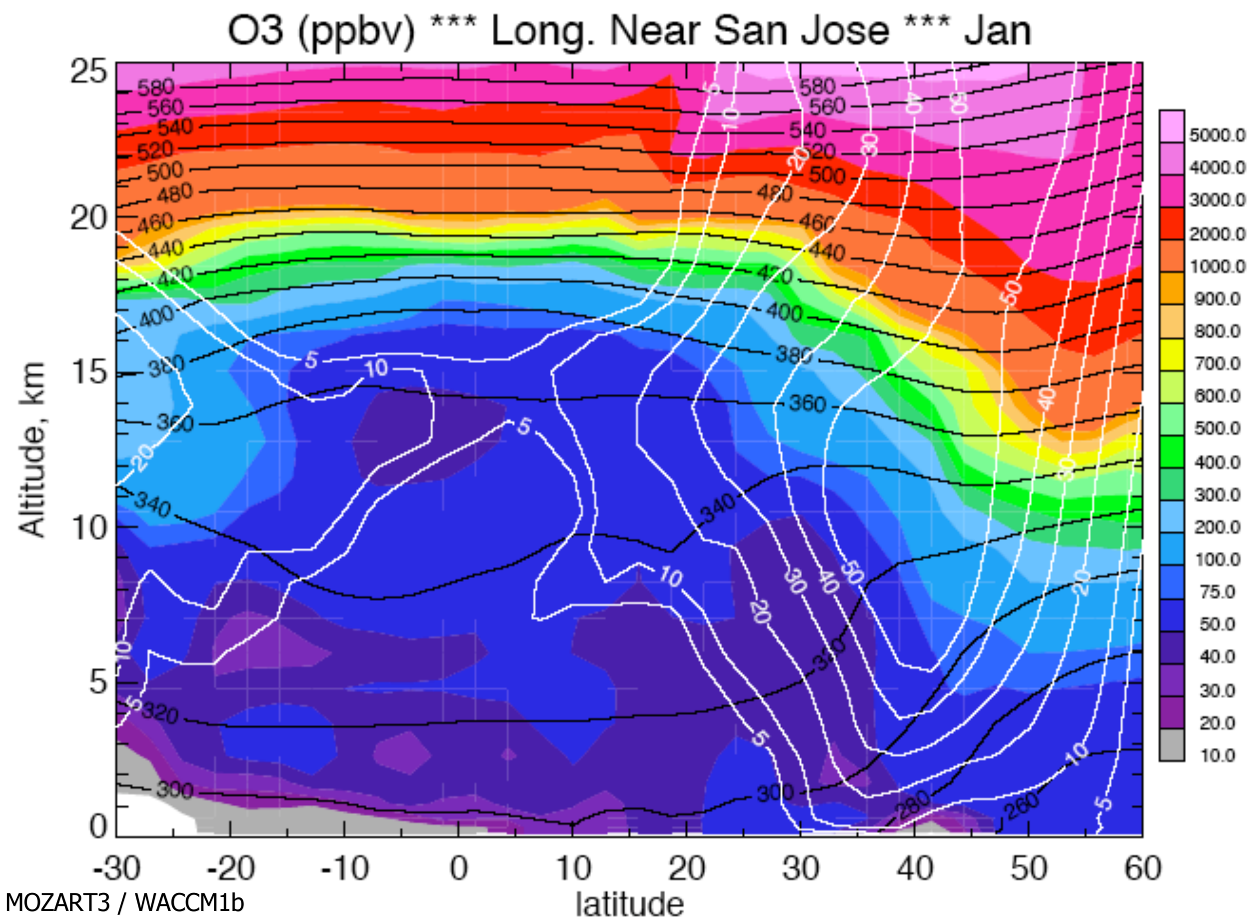
Validation Opportunities from an RB57 Deployment in Costa Rica-H_2O



- Color contours= H_2O vapor (ppmv)
- Black lines = T (K) contour lines
- White lines = Zonal winds (m/s)

- This and next 2 slides show MOZART 3 model calculations of cross-sections of the tropical atmosphere in January
  - This water vapor cross-section shows the very cold, sharp tropical cold point tropopause, and the very low water vapor concentrations expected there.
- These conditions present the best opportunity so far to evaluate HIRDLS ability to retrieve the water vapor distribution under the most difficult conditions (low temperature, low water vapor) and fine vertical structure

Validation Opportunities from an RB57 Deployment in Costa Rica-O_3

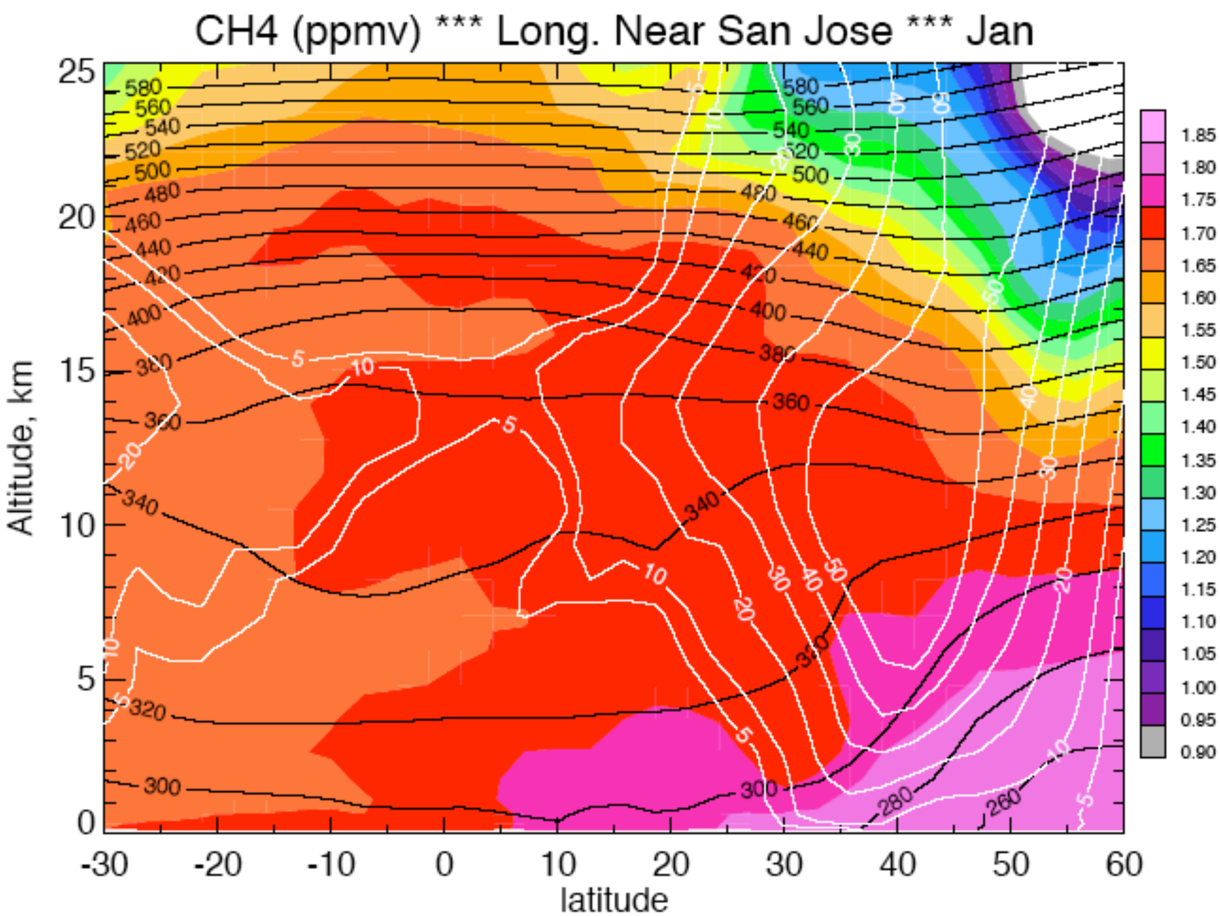


- Color contours= O_3 (ppbv)
- Black lines = T (K) contour lines
- White lines = Zonal winds (m/s)

- Ozone is expected to increase rapidly from low tropospheric values around the tropopause

- This is also the best opportunity to evaluate retrievals under difficult conditions of low temperatures, low concentrations and rapid vertical variations.

Validation Opportunities from an RB57 Deployment in Costa Rica-CH_4



- Methane and other long-lived tracers do not show strong vertical gradients in the tropics. However, their values, in a region of low gradients along the line of sight, will be very useful in HIRDLS validation.

- Color contours= CH_4 (ppmv)
- Black lines = T (K) contour lines
- White lines = Zonal winds (m/s)

Priorities During the Remote Sensing Period

- 1. Location and altitude of cirrus layers and opaque cloud tops
  - Using CPL, ACAM, CRS, COSSIR?
  - Need high-altitude flights along HIRDLS scan track
- 2. Vertical profiles of H_2O, O_3, and Temperature to as high an altitude as possible, hopefully through the cold point tropopause
- 3. Profiles of CH_4, N_2O, F11, and F12
  - Not much vertical variation, but the values will be very useful for HIRDLS data validation

Priorities During the In-Situ Period

- 1. Vertical profiles of H_2O, O_3, HNO_3 and Temperature to as high an altitude as possible, hopefully through the cold point tropopause

- 2. Location and characterization of aerosols, including size distribution and composition

- 3. Profiles of CH_4, N_2O, F11, and F12
  - Not much vertical variation, but the values will be very useful for HIRDLS data validation

HIRDLS Requirements for CR- AVE - Summary

Species profiles in regions with strong vertical gradients.
- Vertical extent: approx. 10km - to max altitude of WB57.
- Clear LOS (no dense clouds) at altitudes > 14 km preferred, lower desirable.
- Correlative data vertical resolution
- At HIRDLS tangent track.

Validation of Cirrus
- Long flights with the CPL, at least in large part above clouds.

Validation of H_2O
- Lowest H_2O at cold temperatures preferred.

Validation of long lived trace gases
- Vertical profiles above clouds needed

HIRDLS coincidence with H_2O and Ozone sondes in Costa Rica very valuable.

Flight Plans

- Cirrus-hunting flights
  - Remote - CRS, CoSSIR, CPL
  - In situ - convective outflow
  - Sub-visible cirrus
- TTL profiling
  - Ozone, H2O, isotopes, etc.
  - Crenellation or porpoising
- Lagrangian
  - Cirrus
  - Continental blow-off
  - Convective influence
- Deep profiling flights

Thompson Logistics

- Need passport images - picture & signature pages. Electronic files, NO FAXES!
- Need travel data (embassy requirement) - RMBKendall@aol.com
- Rental cars will be available at CENAT/NASA hangar when C5 arrives
- AVIS will leave cars at the Clear Lake Residence Inn for the return flight from Costa Rica (please notify AVIS in advance).